THE EFFECT OF SMARTPHONE USE ON THE PERCEPTION OF TIME

A Thesis

by

BETHANY LUANNE HARRIS

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Sherecce Fields
Committee Members,	Hart Blanton
	Steven Smith
	Leslie Morey
Head of Department,	Heather Lench

May 2020

Major Subject: Psychology

ABSTRACT

The growing popularity of smartphone adoption and use has prompted researchers to investigate the implications of their problematic use. Despite the many benefits attributed to mobile phone and smartphone technology, many have theorized that the problematic use of this technology may negatively impact users cognitively, emotionally, or behaviorally. This study examined the relationships between boredom proneness, smartphone use, and perception of time while controlling for other variables such as working memory and IQ in three experimental conditions: Waiting, Social Media, and Lecture. Participants ($N = 207$) were asked to document how much time they perceived to have passed during the seven-and-a-half-minute experiment. Participants were asked to record how much time they spent using their smartphone devices in the prior week. Results were surveyed using ANOVA, ANCOVA, and linear regression analyses. The ages of the students included in the analyses ($n = 164$) ranged from 18 to 24 years old ($M_{age} = 19.27$, $SD = 1.2$, 59.8% female). Emerging adults perceived more time as passing while watching the academic lecture, $F(2,130) = 3.49$, $p < 0.05$. There was also a marginally significant interaction effect indicating that high smartphone users perceived more time as passing while watching the academic lecture video compared to those in both the Waiting and Social Media conditions, $F(2,130) = 2.76$, $p = 0.067$. Finally, individuals with higher levels of boredom proneness perceived less amount of time passing during the “Lecture” condition compared to those with lower levels of boredom proneness ($b = -0.12$, $t_{(48)} = -2.29$, $p < 0.05$). Future research should examine other potential influences of time perception in various settings.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supported by a thesis committee consisting of Sherecce Fields, Leslie Morey, and Steven Smith of the Department of Psychological and Brain Sciences and Hart Blanton of the Department of Communication.

All other work conducted for the thesis was completed by the student independently.

Funding Sources

Graduate study was supported by a fellowship from Texas A&M University.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION AND LITERATURE REVIEW

The popularity of smartphones is undeniable in nearly all facets of society – across age groups, ethnic backgrounds, socioeconomic status, and education. Pew Research Center conducted a research study between 2000 and 2016 on smartphone use and found that 77% of all Americans and 92% of American young adults own a smartphone. Smartphone adoption was shown to have more than doubled since 2011, when only 35% of Americans reported smartphone ownership (Rainie & Perrin, 2017). There are numerous benefits attributed to this technology, including enhanced and diverse methods of communication, access to all facets and modes of the Internet, and a consolidation of nearly all other forms of technology previously used on other devices. Despite these many benefits, concern has grown over the potential implications of dependency upon and excessive use of smartphone devices on users' executive functioning.

A standard cut-off point to determine at what point smartphone use becomes problematic has yet to be established. However, Billieux (2012) has defined problematic smartphone use as "an inability to regulate one's use of the mobile phone, which eventually involves negative consequences in daily life" (p. 1). Similarly, although the problematic use of mobile phone and smartphone technology has been studied for nearly 14 years, a standard conceptualization or definition of problematic smartphone use has yet to be established in the field of psychological research. Toda, Monden, Kubo, and Morimoto (2004) developed and validated the first assessment tool measuring and identifying the behavior in regards to cellular phone usage and the behavior was conceptualized as being a dependency-related issue. Bianchi and Phillips (2005) defined it as problem use behavior. Jenaro, Flores, Gómez-Vela, González-Gil, and

Caballo (2007) used the term “overuse” when developing a scale to identify and measure the behavior. “Excessive cellular phone use” was measured by Ha, Chin, Park, Ryu, and Yu (2008) and, finally, Leung (2008) was one of the first studies to describe the behavior as being addictive in nature when they developed the Mobile Phone Addiction Index (MPAI). It is important that the terminology being used when assessing, identifying, and conceptualizing this behavior be standardized. Further research on how the behavior is developed and manifested will help to do so. However, for the purposes of this study, the phrase “problematic smartphone use” will be utilized to address the behavior.

Associated Dysfunction

Impulsivity

The inconsistency in conceptualization of the behavior has made it more difficult to theorize and identify associated dysfunction. However, one of the most consistently investigated cognitive factors theorized to be associated with problematic smartphone use is impulsivity due to its association with addiction- and dependency-related disorders such as substance use disorders (see Verdejo-Garcia et al., 2008; Stautz & Cooper, 2013; Bloom & Matsko, 2014; and Tomko et al., 2016 for reviews) and gambling disorder (see Chowdhury, Livesey, Blaszczynski, & Harris, 2017 for a review). One commonly referenced model used to conceptualize impulsivity is the five-factor UPPS-P model (Lynam et al., 2006). The UPPS-P model emphasizes the multi-faceted and multi-dimensional nature of the behavior with the following factors: negative urgency; lack of premeditation; lack of perseverance; sensation seeking; and positive urgency.

Negative urgency is described as being the tendency to act rashly under extreme negative emotions (Whiteside & Lynam, 2001) and has been shown to be related to problematic smartphone use (Billieux, Van del Linden, & Rochat, 2008; Billieux, Van der Linden, D'Acremont, Ceschi, & Zermatten, 2007). Billieux et al. (2007) found that individuals with high levels of negative urgency as measured by the UPPS-P will struggle more with limiting use of their smartphones during conditions of negative affect and will experience greater feelings of dependence upon their smartphones. Billieux et al. (2008) found that lack of premeditation (the tendency to act without thinking) and lack of perseverance (the inability to remain focused on a task; Whiteside & Lynam, 2001) also played specific roles in problematic smartphone use but were not found to be as strong of predictors as negative urgency. Finally, sensation seeking (the tendency to seek out novel and thrilling experiences) has been shown to be related to the problematic use of smartphone devices (Divband, 2013; Leung & Liang, 2016; Billieux et al., 2008). Burnell and Kuther (2016) found that problematic smartphone use may be fueled by the individual's desire to be exposed to novel stimuli in combination with poor impulse control. Although a causal relationship has been yet to be determined, it has been routinely shown that adolescents and young adults who problematically use their smartphones are more likely to be impulsive.

Attention Deficits

Additionally, problematic smartphone use has been shown to be related to impaired attention. In a population of South Korean adolescents, mobile phone dependency negatively predicted attention (Seo, Park, Kim, & Park, 2016). These findings showed that mobile phone dependency increases attention problems of middle school students. As such, their study further showed that these attention issues impacted academic achievement. Attention impulsiveness, one of the Barratt Impulsiveness Scale's (BIS; Barratt, 1959) three impulsiveness factors capturing one's inability to concentrate on the topic at hand, was similarly found to have a significant relationship with cell phone addiction (Roberts, Pullig, & Manolis, 2015). Impaired attention has been shown to be related to the problematic use of other forms of technology such as the Internet (Ho et al., 2014; Kaess et al., 2014; Sung, Shin, & Cho, 2014) and video games (Gentile, 2009; Panagiotidi, 2017), as well.

Not surprising based on research on different facets of impulsive behavior, problematic smartphone use has been shown to be correlated with attention-deficit/hyperactivity disorder (ADHD) diagnoses. In a U.S. population of adults ranging in age from 19 to 40 years old, Kim (2018) found that those with ADHD showed higher levels of problematic use of smartphones than those without ADHD. Similarly, Seo et al. (2016) confirmed that U.S. adults with ADHD symptoms were more likely to be "trapped" by problematic smartphone use compared to those who lacked ADHD diagnoses. However, it is important to note that no causal relationship has been established between ADHD and problematic smartphone use. Some posit that individuals with ADHD seek out excessive stimulation and, therefore, tend to overuse their smartphone devices. However, it has been theorized that preoccupation with and overconsumption of media and technology has resulted in problematic "media multitasking" in U.S. adolescents and emerging adults leading technology users to develop a need to switch between multiple sources of information (see Rideout, Foehr, & Roberts, 2010) possibly mimicking the symptoms of ADHD. This led Rosen, Cheever, and Carrier (2012) to posit that many individuals might be suffering from an ADHD-like "iDisorder" due to the similarities in symptomology between ADHD and the problematic use of media and technology such as smartphone devices.

This theory regarding “media multitasking” and an inability to focus on one task stemming from problematic technology use was further supported by a study conducted by Rosen, Carrier & Cheever (2013). They found that middle school, high school, and college students can be easily distracted while studying at home when they have technological devices present. Students had a difficult time focusing on their main task and, on average, stayed on task for less than six minutes before becoming distracted and switching to another task. Carr (2011) argued that this kind of rapid attention shifting involved in multitasking could lead to an inability to focus and a perpetually shallow level of processing information. It is theorized that the excessive use of smartphone devices might be causing users to develop cognitive impairments such as shortened attention span and impulsivity similar to those associated with ADHD.

Boredom Proneness

Finally, boredom proneness has been shown to be linked to problematic smartphone use. In a study assessing boredom and risk behaviors in adolescents during free time, Biolcati, Mancini, and Trombini (2018) found that adolescents with higher levels of boredom proneness use technological devices such as smartphones more frequently and were also more at risk of Internet addiction than adolescents with lower levels of boredom proneness. More studies have investigated the relationship between boredom proneness and problematic Internet use than those that have measured problematic smartphone use. Through the development of the Internet Addiction Scale (IAS), Nichols and Nicki (2004) found boredom proneness to be significantly correlated with Internet addiction. Skues, Williams, Oldmeadow, and Wise (2015), assessing problematic Internet use in undergraduate university students, also found boredom proneness to be a significant predictor of problematic Internet use. Similarly, boredom proneness has been shown to be related with substance use disorders. Biolcati, Passini, & Mancini (2016) found that boredom proneness is predictive of adolescents' binge drinking and referenced additional studies suggesting that boredom proneness is also linked to abuse of other substances such as marijuana, psychedelics, and other stimulants in addition to alcohol (Iso-Ahola & Crowley, 1991; Hunter & Csikszentmihalyi , 2003).

Time Perception

Perception of time is a complex cognitive process that is conceptualized and measured in many various ways. For example, time estimation, time distortion, time perception, subjective time perception, internal clock speed, time reproduction, time discrimination, time production, and perceptual timing functions are all terms that are either used independently or interchangeably to refer to the cognitive function. Generally, however, there are two distinct paradigms used to describe the explicit judgment of time by individuals. These paradigms include prospective timing and retrospective timing. Prospective timing involves participants being informed before they perform the task that they will be required to make a time-related judgment. In contrast, retrospective timing involves participants being given no prior warning of having to perceive passing time (Grondin, 2010). The majority of research studies investigating perception of time have utilized very brief time intervals, often in the millisecond range, using the prospective timing paradigm. Few studies have investigated retrospective timing especially in relation to cognitive dysfunction or psychological conditions using longer time intervals.

Distorted perception of passing time has been shown to have negative implications for daily life such as in terms of one's decision-making processes. Wittmann & Paulus (2008) discuss in their review of the literature on impulsivity and perception of passing time the significant role time perception plays in decision-making and its influence on delay discounting in impulsive individuals. It is described how impulsive individuals tend to devalue delayed rewards at various intervals more strongly than less impulsive individuals and they suggested that this might be due to their distorted perception of time, a trend that has been indicated in various studies (Corvi, Juergensen, Weaver, & Demaree, 2012; Tsai & Yeh, 2014; Moreira, Pinto, Almeida, & Barbosa, 2016). It is suggested that impulsive individuals will choose smaller and more immediate rewards over those that they would be delayed in receiving despite being larger in size compared to less impulsive individuals.

It has also been theorized that this distorted perception of passing time seen in impulsive individuals can be attributed to their need to allocate more attention resources to the passage of time due to the distress they experience when they are unable to alleviate their impulses (Wittmann, Leland, Churan, & Paulus, 2007). For example, in waiting situations in which they are unable to occupy themselves with distraction or entertainment, it is suggested that impulsive individuals will consciously attend to the passing of time more so than non-impulsive individuals leading them to overestimate their perception of the duration. This phenomenon is also seen in substance use disorders. Sayette, Loewenstein, Kirchner, and Travis (2005) found that high-crave smoking-addicted individuals perceive a greater amount of time as passing than low-crave smoking-addicted individuals. This could be attributed to the same theory that these individuals are allocating more attention resources to the passage of time so they overestimate the duration.

In a study conducted by University of Virginia psychologists seeking to investigate how emerging adults handle being undistracted for a period of time, Wilson et al. (2014) found, unsurprisingly, that most people prefer to do something as opposed to doing nothing. They conducted 11 studies in which college students were asked to sit alone in a room whether at the laboratory or in their own homes and to entertain themselves with their thoughts without using means of distraction or stimulation such as their smartphone devices. For 6 to 15 minutes, depending on the study, 57.5% reported that it was difficult to concentrate and 32% reported that they had "cheated" by distracting themselves by listening to music or using their smartphone devices. An administered Poor Attentional Control subscale assessing factors such as tendency to be easily bored negatively correlated with enjoyment of the experience. This indicates that participants who are more prone to boredom are less able to sit for a period of time without distraction compared to those with less boredom proneness.

Wilson et al.'s (2014) findings also indicated something more surprising about young adult willingness to remain unstimulated and undistracted for relatively short periods of time. Participants in one of their studies were given the same task of sitting undistracted for 15 minutes, but, in this experiment, they were given the opportunity to receive an electric shock by pressing a button. Before the experiment began, participants were given the shock sensation and asked whether or not they would pay to not receive the shock in the future. It was found that 67% of the men and 25% of the women who had previously stated that they would pay money to not experience the pain of the shock gave themselves at least one shock during the duration of the 15 minute experiment anyway. Although this study did not assess perception of passing time, this further indicates the potential influence of boredom proneness, impulsivity, and sensation-seeking in young adults on their perceived experiences of undistracted periods of time.

Boredom proneness has been shown to be related to distorted perception of time in other studies, however. In a factor analytic study of the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986), Vodanovich and Kass (1990) found that the five factors making up the validated scale included: external stimulation, internal stimulation, affective responses, constraint, and perception of time. Watt (1991) assessed undergraduate participants' boredom proneness and perception of passing time during a number-circling task. It was determined that highly boredom-prone undergraduate students perceived more time as passing during the task than low boredom-prone students. Similar to Wittmann et al.'s (2007) theory regarding impulsive individuals allocating more attentional resources to the passage of time resulting in their subjective overestimations, it is possible that boredom prone individuals similarly attend to passing time more consciously and, therefore, perceive more time as passing than individuals who are less prone to boredom.

Finally, individuals with attentional deficits and/or ADHD diagnoses have been shown to have distorted perceptions of time (Radonovich & Mostofsky, 2004; Shur-Fen Gau & Shoou-Lian, 2010; Walg, Hapfelmeier, El-Wahsch, & Prior, 2017; and others), as well. This impairment has inconsistently been attributed to various characteristics such as working memory deficits (Bauermeister et al., 2005; Lee & Yang, 2018), distractibility (Wittmann & Paulus, 2008), and lower processing speed (Walg et al, 2017). Therefore, not only has it been shown that impulsivity, boredom proneness, and attention deficits are each independently associated with problematic smartphone use, but each cognitive factor is also related to distorted perception of time, as well. In light of these findings, it is possible that there is a direct relationship between problematic smartphone use and distorted perception of time.

It is also theorized that problematic smartphone users might exhibit similar cognitive and behavioral tendencies in waiting situations as impulsive and/or substance addicted individuals. Wittmann et al. (2007) described how impulsive individuals might allocate more attention resources to the passage of time due to the distress they experience when they are unable to alleviate their impulses. In low-stimulation or waiting situations in which they are unable to utilize the technological device that typically serves as a stimulating distraction, individuals who problematically use their smartphones might perceive that a greater amount of time has passed compared to individuals who have less exposure to the stimulating device. Additionally, problematic smartphone use has been conceptualized by some as being a dependency issue and by others as being a behavioral addiction. Although currently there is no standardized conceptualization of the problematic behavior, it is possible that individuals who problematically use their smartphones are more dependent upon or even addicted to the device. If this is the case, it is possible that these individuals might perceive more time as passing when they are in less stimulating situation and unable to use their devices similar to those smoking-addicted individuals in Sayette et al.'s (2005) study.

Few studies have investigated the relationship between problematic technology use and distorted perception of time. Greenfield (1999) found that time distortion was one of many factors contributing to problematic Internet use. However, this distortion of time was in terms of participants reflecting upon how often they lose track of time. Individuals who were identified as being addicted to the Internet described "timelessness" or losing track of time as happening very frequently. More recently, yet still nonspecific to smartphone use, Gonidis & Sharma (2017) conducted a study in order to assess university students' perception of time in the millisecond range when exposed to Internet salient stimuli on computer screens. They found that students overestimated the amount of time they were exposed to Facebook related stimuli compared to Internet related stimuli. However, neither study utilized retrospective timing to assess perception of passing time with longer intervals in respect to technology overuse, let alone examined perception of passing time in relation to problematic smartphone use specifically.

Hypothesis

It is predicted that perception of passing time will be greater under conditions lacking stimulation or entertainment (i.e., waiting alone in a room for further instructions) compared to conditions under which individuals are stimulated (i.e., social media usage). It is also predicted that participants with a greater amount of smartphone use who are inactive or unstimulated will perceive that a significantly greater amount of time passed during the experiment compared to those with moderate or low smartphone use. Finally, it is hypothesized that boredom proneness might mediate this relationship with boredom proneness being positively related to both smartphone use and perception of passing time.

Significance

If it is determined that problematic smartphone use is associated with the alteration of users' perception of time, this could have very significant implications on both the societal and individual levels. In academic settings, it is possible that university students who problematically use their smartphones are becoming less able to withstand the length of typical academic lectures without the use of technology to stimulate and distract them. This inability to remain focused on the lecture might be negatively impacted by a student's distorted perception of time because they might perceive more time as passing and may subsequently give up more easily on paying attention. This is supported by studies indicating that media multitasking with technology during class has been shown to have negative impacts on retention of information, note-taking, and course grades (Harman & Sato, 2011; Wood et al., 2012; Clayson & Haley, 2013; Bjornsen & Archer, 2015).

Additionally, because perception of passing time has been shown to be associated with decision making in terms of one's ability to delay gratification, students who problematically use their smartphones and, as a result, experience time distortion may become more impulsive with decisions regarding devalued delayed rewards. This can have significant impacts on various areas of their lives. Specifically, this could increase their likelihood of texting while driving. Hayashi, Miller, Foreman, and Wirth (2016) found that individuals who self-reported as frequently texting while driving discounted the chance to look at their phone and read and reply to a text message at greater rates compared to those with lower self-reported texting while driving instances. At both the individual and societal levels, this can be very significant due to the risk and dangers of distracted driving due to technology use.

2. METHODS

Participants

Participants in this study were adults (*n* = 207) enrolled at Texas A&M University in College Station, TX (see Table 1). Participants were recruited for the study from the Department of Psychological and Brain Sciences' subject pool and received course credit for their participation. The ages of the participants ranged from 18 to 53 years old (M_{age} = 19.44, *SD* = 2.7, 59.9% female). The majority of these participants identified as Caucasian (56.5%), while lesser amounts self-reported as Hispanic/Latino (21.3%), Asian (7.2%), African American (5.3%), Native American (0.5%), or mixed (9.2%). However, 43 participants were excluded from analyses due to exceeding the emerging adulthood age range, administration errors, or having insufficient or invalid data. Emerging adulthood is commonly characterized as occurring between the ages of 18 and 25 years (Arnett, 2000). Therefore, two individuals were excluded from analyses because they exceeded 25 years of age. Additionally, because quantitative data regarding participants' previous week's smartphone use is necessary for analyses, and this data can only be consistently gathered from iPhone owners, 33 individuals were excluded from analyses due to either not owning an iPhone smartphone device or due to being unable to otherwise report their smartphone usage during the prior week. Two individuals were excluded from analyses due to incomplete survey data and four additional individuals were excluded due to administration errors resulting in an inability to document perception of time during the experiment. Finally, two individuals were excluded from analyses due to their data being identified as invalid.

The ages of the students included in the analyses (*n* = 164) ranged from 18 to 24 years old (M_{age} = 19.27, *SD* = 1.2, 59.8% female; see Table 2). Most of these participants identified as Caucasian (58.5%), while lesser amounts self-reported as Hispanic/Latino (21.3%), Asian (5.5%), African American (4.9%), Native American (0.6%), or mixed (9.1%).

Procedure

This experiment was a quantitative study assessing undergraduate students' perception of passing time or retrospective time perception. Upon being consented, participants were instructed to complete a demographic questionnaire and the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986). They were also asked to utilize their smartphone devices to determine and document the exact amount of time spent on their smartphones in the prior week found in their smartphone's settings. The participants then began the experimental portion of the study. Upon being consented for a second time, they were randomly assigned to one of the following groups: the "Waiting" group (*N* = 61), in which they were instructed to wait for further instructions without distraction; the "Social Media" group (*N* = 53), in which they watched a screen-captured video of the use of a social media application; or the "Lecture" group (*N* = 50), in which they were instructed to watch a video of a lecturer discussing a neutral topic (Introduction to World History) in a university setting. Each group's activity or lack thereof lasted exactly seven and a half minutes. Following the completion of the experiment, the participants were asked to report how much time they perceived as passing during the time that they were waiting or watching the video. Finally, the participants were assessed for intelligence and working memory.

Measures

Demographics

Basic demographic information including age, ethnicity, university classification, and sex were obtained from participants (see Appendix A).

Smartphone Use

Many studies have had participants estimate how much time they spend using their smartphones on average per week in order to assess overall smartphone use. However, Andrews, Ellis, Shaw, and Piwek (2015) found that estimated smartphone use should be interpreted with caution in psychological research due to a significant inconsistency between participants' self-reported estimates and actual smartphone use. Because of this, objective information regarding smartphone use was obtained from participants. Basic instructions were provided to participants directing them to the location of their smartphone application usage throughout the prior week in their smartphones (see Appendix B). Participants were asked to verify that they understood the instructions and then to document the amount of time spent on their smartphone devices during the prior week. Higher values of smartphone use indicate greater amounts of smartphone device use time during the week prior to participating in the study. One week's smartphone use was used to determine average weekly smartphone usage. The average amount of time spent on smartphone devices by these participants during the week prior to the study was 27.8 hours (SD = 15.9).

Participants were classified as High smartphone users when their prior week's smartphone use exceeded 27.8 hours – the sample's average weekly smartphone use. Alternatively, participants were classified as Low smartphone users when their prior week's smartphone use did not exceed 27.8 hours. Subsequently, 81 participants were classified as Low smartphone users and 83 participants were classified as High smartphone users. The average amount of time spent on smartphone devices by High smartphone users during the week prior to the study was 40.2 hours (*SD* = 10.6). The average amount of time spent on smartphone devices by Low smartphone users during the week prior to the study was 15.0 hours (*SD* = 8.5).

Boredom Proneness

Each participant then completed the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986) (see Appendix C) developed in response to the identified disparity between the importance of boredom as an issue in psychology, education, and industry and the dearth of research on the subject. The scale was originally in a true-false format. However, the scale provides the option to convert the items into a Likert scale format. A 7-point format is recommended ranging from "1" (highly disagree) to "7" (highly agree). This format was modified in order to use a 6-point format ranging from "1" (highly disagree) to "6" (highly agree) to eliminate the possibility of participants recording neutral responses to the items. High scores on the BPS indicate higher levels of boredom proneness. The participants' average BPS score was 88.2 (*SD* = 11.7). The internal consistency (Cronbach's alpha) of the BPS was 0.751 in the present sample.

Participants were classified into the High boredom proneness category when their BPS score exceeded 88.2 – the sample's average BPS score. Alternatively, participants were classified into the Low boredom proneness category when their BPS score did not exceed 88.2. Subsequently, 82 participants were classified as having High boredom proneness and 82 participants were classified as having Low boredom proneness. The average BPS score of the participants classified as having High boredom proneness was 98.0 (*SD* = 6.8) while the average BPS score of the participants classified as having Low boredom proneness was 78.5 (*SD* = 6.1).

Working Memory

Working memory has been shown to influence perception of passing time (Lee & Yang, 2018; Ahmadi, Moradi, Esmaeili, Mirabolfathi, & Jobson, 2019). As such, the Operation Span (OSPAN) working memory task (Turner & Engle, 1989; Sheslow & Adams, 2003) was used to assess participants' working memory in order to serve as a covariate in this study. During the OSPAN working memory task, participants were presented with a sequence of letters with each letter in the sequence being preceded by a math problem (e.g., [8*2] - 8 = ?) and a proposed solution for which participants must indicate if it is correct or incorrect. Participants are then instructed to recall the letters previously presented. High scores on the OSPAN indicate greater working memory capabilities. Due to technical errors, the OSPAN was only successfully completed by 163 participants. The average working memory score was 61.4 (SD = 9.6).

Intelligence

Similarly, intelligence has been shown to influence perception of passing time (Fink & Neubauer, 2005) and, in studies on perception of passing time, has served as a covariate (e.g., Lee & Yang, 2018). Thus, the Kaufman Brief Intelligence Test – Second Edition (KBIT-2; Kaufman & Kaufman, 2004) was used to assess participants' intelligence so that IQ could similarly serve as a covariate for the present study. The KBIT-2 is a brief measure of verbal and nonverbal intelligence taking approximately 20 minutes to administer. Verbal, Nonverbal, and IQ Composite scores were calculated for participants. High Composite IQ scores on the KBIT-2 indicate higher levels of intelligence. Due to administration errors, the KBIT-2 was only successfully completed by 139 participants. The KBIT-2 utilizes standard scores (M = 100, SD = 15). The average Composite IQ score for this study was 102.0 (SD = 11.2).

Data Analyses

The IBM SPSS Statistics 24 package was used to perform the data analyses. ANOVA, ANCOVA, and mediational analyses were conducted to explore the major hypotheses. ANOVA tests were used to determine if there are significant differences in sex, age, working memory, intelligence, and study administration time across the three conditions. ANCOVA tests were also used to assess differences in the perception of time of high and low frequency smartphone users across the three conditions as well as that of participants with high and low levels of boredom proneness. Linear regression analyses were used to determine if amount of smartphone use and/or boredom proneness predicted perception of passing time in each of the three conditions. For conditions where boredom proneness and smartphone use were independently shown to be predictive of perception of passing time, mediational analyses were then used to determine if boredom proneness mediates relations between smartphone use and perception of passing time.

Exploratory Data Analyses

Exploratory data analyses were conducted to determine if subgroups of smartphone usage uniquely influence perception of passing time in each of the three conditions. When documenting their smartphone use, participants were also asked to document the amount of time their smartphone devices reported that they had spent using smartphone applications during the past week corresponding to the following listed categories: Social Networking, Productivity, Reading & Reference, Creativity, Education, Entertaining, and Games. Linear regression analyses were used to determine if use of applications in each of the previously listed categories predicted perception of passing time in each of the three conditions.

3. RESULTS

ANOVA analyses were used to determine if there were significant differences in sex, age, working memory, or intelligence across the three conditions (Waiting, Social Media, and Lecture). ANOVA tests revealed that, across the three conditions, there were not significant differences in sex ($F[2,161] = 0.27$, $p > 0.05$); age ($F[2,161] = 1.14$, $p > 0.05$); working memory ($F[2,160] = 0.06$, $p > 0.05$); or intelligence ($F[2,136] = 1.09$, $p > 0.05$). Additionally, an ANOVA test was used in order to determine if there were significant differences between time of day when the study was administered across the three conditions. An ANOVA test revealed that, across the three conditions, there were not significant differences in time of day when the study was administered, $F(2, 161) = 1.50$, $p > 0.05$.

Simple correlation analyses were conducted to examine relations between boredom proneness, smartphone use, working memory, intelligence, and time perception. Across all participants, independent of conditions, boredom proneness and smartphone use were not found to be significantly correlated, $r_{(162)} = -0.04$, $p > 0.05$. Similarly, boredom proneness was not found to be significantly correlated with smartphone use for participants within any of the experimental conditions: Waiting ($r_{(59)} = -0.08$, $p > 0.05$); Social Media ($r_{(51)} = 0.05$, $p > 0.05$); Lecture ($r_{(48)} = -0.09$, $p > 0.05$). These findings suggest that emerging adult boredom proneness levels and smartphone use frequency are unrelated constructs.

Additionally, across all participants, independent of conditions, smartphone use was not shown to be correlated with either intelligence ($r_{(137)} = -0.04$, $p > 0.05$) or working memory ($r_{(161)} = 0.03$, $p > 0.05$). Similarly, boredom proneness was not shown to be correlated with either intelligence ($r_{(137)} = 0.00$, $p > 0.05$) or working memory ($r_{(161)} = -0.02$, $p > 0.05$). Finally, intelligence and working memory were shown to be significantly and positively correlated, $r_{(136)} = 0.30$, $p < 0.001$. Correlations between each of the study's primary variables (e.g., smartphone use, boredom proneness, working memory, intelligence, and time perception) for Waiting, Social Media, and Lecture conditions can be found in Tables 3, 4, and 5, respectively. Additionally, correlations between each of the study's primary variables with the exception of time perception across the entire sample independent of condition can be found in Table 6.

Results were initially analyzed using a 3 (Condition) by 2 (High / Low Smartphone Use) ANOVA test to determine if there were significant differences in perception of passing time between individuals with High or Low smartphone use across each of the three conditions. The ANOVA test revealed that there was no significant main effect for experimental condition on perception of passing time, $F(2, 158) = 2.29$, $p > 0.05$. Additionally, there was not a significant main effect for categorical (High vs. Low) smartphone use on perception of passing time, $F(2, 158) = 0.46$, $p > 0.05$. Finally, there was no significant interaction effect, $F(2,158) = 1.58$, $p > 0.05$.

However, upon including intelligence and working memory as covariates to partial out their variance using a 3 (Condition) by 2 (High / Low Smartphone Use) ANCOVA test, experimental condition was significant in predicting perception of passing time, $F(2,130) = 3.49$, $p < 0.05$, such that participants perceived a significantly greater amount of time as passing while watching the academic lecture compared to those who were watching the video of social media use. Although smartphone use categories was not shown to be significant ($F[2,130] = 0.73$, $p > 0.05$), the interaction between experimental condition and smartphone use categories was marginally significant in predicting perception of passing time, $F(2,130) = 2.76$, $p = 0.067$. This suggests that high smartphone users perceived more time as passing while watching the academic lecture video compared to high smartphone users in both the Waiting and Social Media conditions (Figure 1). Additionally, low smartphone users in the Social Media condition perceived a significantly less amount of time as passing compared to those in both the Waiting and Lecture conditions.

Linear regression analyses were used to determine if amount of smartphone use predicted perception of passing time in each of the three conditions. In the "Waiting" condition, participants' amount of smartphone use during the previous week did not significantly predict the amount of time they perceived to have passed while they were waiting for 7.5 minutes (b = -0.23, $t_{(59)} = -0.97$, $p > 0.05$). In the "Social Media" condition, participants' weekly smartphone use did not significantly predict the amount of time they perceived to have passed while they were watching the social media use video for 7.5 minutes ($b = 0.01$, $t_{(51)} = 0.31$, $p > 0.05$). Finally, in the "Lecture" condition, participants' weekly smartphone use did not significantly predict the amount of time they perceived to have passed while they were watching the academic lecture video with the same duration ($b = 0.01$, $t_{(48)} = 0.30$, $p > 0.05$).

Results were then analyzed using a 3 (Condition) by 2 (High / Low Boredom Proneness) ANOVA test to determine if there were significant differences in perception of passing time between individuals with High and Low levels of boredom proneness across each of the three conditions. The ANOVA test revealed that there was no significant main effect for experimental condition on perception of passing time, $F(2, 158) = 2.45$, $p > 0.05$. Additionally, there was not a significant main effect for High versus Low levels of boredom proneness on perception of passing time, $F(2, 158) = 3.32$, $p > 0.05$. Finally, there was no significant interaction effect, $F(2,158) = 7.71$, $p > 0.05$.

However, upon including intelligence and working memory as covariates to partial out their variance using a 3 (Condition) by 2 (High / Low Boredom Proneness) ANCOVA test, experimental condition was significant in predicting perception of passing time, $F(2,130) = 3.40$, $p < 0.05$, such that participants perceived a significantly greater amount of time as passing while watching the academic lecture compared to those who were watching the video of social media use, similar to the previously reported ANCOVA results examining the role of smartphone use. Additionally, boredom proneness was also significant in predicting perception of passing time, $F(2,130) = 5.02$, $p < 0.05$, such that participants with low boredom proneness perceived a greater amount of time as passing compared to participants with high boredom proneness. Finally, however, the interaction between experimental condition and levels of boredom proneness was not shown to be significant in predicting perception of passing time, $F(2,130) = 0.75$, $p > 0.05$ (Figure 2).

Linear regression analyses were similarly used to determine if individuals' proneness to boredom predicted perception of passing time in each of the three conditions. In the "Waiting" condition, participants' boredom proneness as measured by the BPS did not significantly predict the amount of time they perceived to have passed while they were waiting for 7.5 minutes ($b = -.02$, $t_{(59)} = -0.73$, $p > 0.05$). Similarly, in the "Social Media" condition, participants' boredom proneness did not significantly predict the amount of time they perceived to have passed while they were watching the social media use video for 7.5 minutes ($b = -0.06$, $t_{(51)} = -1.61$, $p > 0.05$). However, in the "Lecture" condition, participants' boredom proneness did significantly predict the amount of time they perceived to have passed while they were watching the academic lecture video for 7.5 minutes ($b = -0.12$, $t_{(48)} = -2.29$, $p < 0.05$; Figure 3). This suggests that individuals with higher levels of boredom proneness perceived less amount of time passing during the

“Lecture” condition video compared to those with lower levels of boredom proneness. Because under no condition were smartphone use and boredom proneness shown to independently predict perception of passing time, no mediation analyses were conducted.

Exploratory Analyses

Linear regression analyses were used to determine if perception of passing time in each of the three conditions was predicted by use of smartphone applications in the following categories: Social Networking, Productivity, Reading & Reference, Creativity, Education, Entertaining, and Games. In the Waiting condition, participants’ perception of passing time was not significantly predicted by use of smartphone applications in the following categories: Social Networking ($b = 0.00$, $t(59) = 0.02$, $p > 0.05$); Productivity ($b = 0.26$, $t(59) = 1.26$, $p > 0.05$); Reading & Reference ($b = 0.08$, $t(59) = 1.09$, $p > 0.05$); Creativity ($b = 0.00$, $t(59) = 0.08$, $p > 0.05$); or Games ($b = -0.03$, $t(59) = -0.52$, $p > 0.05$). However, participants’ perception of passing time was significantly and positively predicted by participants’ use of Education-related smartphone applications in this condition ($b = 0.63$, $t(59) = 2.42$, $p < 0.05$). This suggests that participants who spend more time using applications related to education or academics perceived more time as passing when waiting for further instructions compared to those who used Education applications less frequently. Additionally, participants’ perception of passing time was significantly but negatively predicted by participants’ use of Entertainment-related smartphone applications ($b = -0.12$, $t(59) = -2.19$, $p < 0.05$). This suggests that participants who spend more time using smartphone applications for entertainment perceived that a significantly less amount of time had passed when waiting for further instructions compared to those who used Entertainment applications less frequently.

In the Social Media condition, participants' perception of passing time was not significantly predicted by use of smartphone applications in the following categories: Social Networking ($b = 0.03$, $t(51) = 0.64$, $p > 0.05$); Productivity ($b = 0.07$, $t(51) = 0.75$, $p > 0.05$); Reading & Reference ($b = -0.12$, $t(51) = -1.43$, $p > 0.05$); Creativity ($b = -0.06$, $t(51) = -0.40$, $p > 0.05$); Education ($b = -0.06$, $t(51) = -0.85$, $p > 0.05$); or Entertainment ($b = -0.07$, $t(51) = -0.99$, $p > 0.05$). However, participants' perception of passing time was significantly and negatively predicted by use of smartphone applications in the Games category ($b = -0.30$, $t(51) = -2.02$, $p < 0.05$). This suggests that participants who played more games on their smartphone devices perceived less time as passing compared to those who played smartphone game applications less frequently.

In the Lecture condition, participants' perception of passing time was not significantly predicted by use of smartphone applications in the following categories: Social Networking ($b = -0.02$, $t(47) = -0.39$, $p > 0.05$); Reading & Reference ($b = 0.02$, $t(47) = 0.19$, $p > 0.05$); Creativity ($b = 0.33$, $t(47) = 0.55$, $p > 0.05$); Education ($b = 0.02$, $t(47) = 0.20$, $p > 0.05$); Entertainment ($b = 0.03$, $t(47) = 0.69$, $p > 0.05$); or Games ($b = -0.25$, $t(47) = -1.35$, $p > 0.05$). However, perception of passing time while watching the academic lecture video was significantly and positively predicted by participants' use of Productivity-related smartphone applications ($b = 1.58$, $t(47) = -3.35$, $p < 0.01$). This suggests that participants who use smartphone applications falling under the Productivity category perceived a significantly greater amount of time as passing while watching the lecture video than did their peers who use Productivity applications less frequently.

4. SUMMARY AND CONCLUSIONS

The goal of the present study was to evaluate relations between smartphone use, boredom proneness, and perception of passing time under three different conditions: waiting for further instructions, social media use viewing, and lecture video viewing. Participants were able to report actual amount of smartphone usage from the prior week by accessing this information in their iPhone smartphone device's settings and boredom proneness was measured using the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986). Participants were randomly assigned to one of the three conditions with participation in each of the three conditions lasting exactly seven and a half minutes long. Upon completing the experimental portion of the study, participants were asked to report how much time they perceived to have passed while they were either waiting or watching the video. Finally, in order to control for the influence of working memory and intelligence on participants' perception of passing time, working memory and intelligence were assessed using the Operation Span (OSPAN) working memory task (Turner & Engle, 1989) and Kaufman Brief Intelligence Test – Second Edition (KBIT-2; Kaufman & Kaufman, 2004), respectively.

It was hypothesized that participants in less stimulating conditions (e.g., Waiting and Lecture) would perceive a significantly greater amount of time as passing compared to those in the more stimulating condition (e.g., Social Media). Additionally, it was hypothesized that participants with a greater amount of weekly smartphone use would perceive more time as passing in both the Waiting and Lecture conditions. Finally, it was hypothesized that boredom proneness might mediate the relationships between smartphone use and time perception in these conditions with boredom proneness being positively related to both smartphone use and perception of passing time.

After determining that there were not significant differences in sex, age, working memory, intelligence, or time of day during which the study was administered across the three conditions, analyses were conducted to examine relations between smartphone use, boredom proneness, and time perception in each of the three conditions. Findings from this study do not indicate that boredom proneness is related to emerging adult smartphone use refuting the hypothesis that emerging adults with higher frequency of smartphone use would have elevations in levels of boredom proneness. Considering previous studies showing relationships between Internet addiction and elevations in boredom proneness in both adolescent (Biolcati et al., 2018) and emerging adult (Nichols & Nicki, 2004; Skues et al., 2015) populations and Biolcati et al. (2018) indicating that adolescents with high boredom proneness use technological devices such as smartphones more frequently, these findings were somewhat surprising. However, these results do corroborate Harris, Regan, and Fields (2019), in that, in a similar undergraduate student sample, boredom proneness was shown to positively correlate with self-reported smartphone addiction but not actual smartphone use. The results from the present study suggest that emerging adult boredom proneness and smartphone use frequency likely do not directly influence each other.

It was determined that there were significant differences in time perception across conditions upon controlling for the influences of intelligence and working memory on perception of passing time. Participants perceived more time as passing while watching the history lecture video compared to those who were watching the video of social media use. This suggests that students may lose track of time more easily while engaging in social media compared to when they are in the academic setting. It is likely that students allocate more attention resources to the passage of time when less stimulated or entertained, such as when they attend classes and listen to lecturers, and may result in students having more difficulty remaining focused. Surprisingly, however, perception of passing time was not significantly longer for those in the waiting condition compared to either the lecture or social media condition. Although the mean amount of perceived time was higher for those in the waiting condition compared to those in the social media condition and lower compared to those in the lecture condition, the differences were not significant. This suggests that, during waiting periods, emerging adults do not lose track of time any differently than when they are engaging in social media use or attending academic lectures.

It was determined that there were not significant differences in time perception between High or Low smartphone users and that perception of passing time could not be directly predicted by frequency of smartphone use across any of the three conditions. This suggests that individuals who use their smartphone devices more frequently do not perceive a greater amount of time passing while waiting, while engaging in social media use, or while watching a video of a lecturer speaking about a neutral topic in an academic setting compared to their peers who use their smartphone devices less frequently. Results from this study indicate that emerging adult smartphone use frequency does not result in distortion of time perception.

However, the interaction between experimental condition and smartphone use categories was marginally significant in predicting perception of passing time. High smartphone users were shown to perceive more time as passing while watching the academic lecture video compared to high smartphone users who were waiting or viewing social media usage. This suggests that higher levels of smartphone use may cause students to attenuate to the passing time during lectures more so than when they are waiting or using their phones. Additionally, low smartphone users perceived less time as passing while viewing social media usage compared to those who were waiting or watching the academic lecture. This suggests that students who do not use their phones excessively feel as though less time passes when engaging in social media use compared to when they are unstimulated in a waiting or lecture setting.

Similar analyses were conducted to determine if boredom proneness levels in emerging adults might influence perception of passing time. Relations between boredom proneness, the experimental conditions, and perception of passing time were examined while controlling for the influences of intelligence and working memory on time perception. Independent of the experimental conditions, significant differences in perception of passing time were observed between participants with high and low levels of boredom proneness. Unexpectedly, participants with higher levels of boredom proneness perceived less time as passing compared to those with lower levels of boredom proneness. In other words, participants who were more prone to boredom perceived that less time passed during the seven and half minutes they participated in the experimental conditions, regardless of the experimental condition to which they were assigned. This suggests that, when individuals are more prone to boredom, they attenuate less to passing time compared to their peers with lower levels of boredom proneness.

Although boredom proneness levels were not shown to significantly predict perception of passing time during the Waiting and Social Media conditions specifically, it was determined that boredom proneness levels did significantly predict perception of passing of time for individuals in the simulated academic lecture setting. Results from this study similarly refute the original hypothesis regarding boredom proneness' role in perception of passing time. Results from this analysis suggest that individuals with higher levels of boredom proneness perceived a significantly less amount of time as passing while watching the lecture video than did their peers with lower levels of boredom proneness. This suggests that individuals who are more easily prone to boredom do not perceive academic lectures to be significantly longer than their peers who are less easily boredom prone. The results of the present study regarding the role of boredom proneness in perception of passing time not only refute the original hypothesis but also conflict with findings from previous studies indicating that highly boredom-prone individuals perceive more time as passing during boredom-inducing tasks (Watt, 1991). It is possible that individuals who are more prone to boredom have adapted to frequently experiencing boredom by day-dreaming during boredom and, subsequently, losing track of time more easily.

Exploratory analyses were conducted in order to further examine the potential influence of smartphone use on emerging adult time perception. Relations between frequency of use of smartphone applications under specific categories (e.g., Social Networking, Productivity, Reading & Reference, Creativity, Education, Entertaining, and Games) and perception of passing time during each of the three conditions were examined. Surprisingly, differing categories of smartphone application usage significantly predicted differences in time perception for each of the three conditions. For participants in the Waiting condition, use of applications in both the Education and Entertainment categories significantly predicted time perception with elevations of Education-application usage positively predicting time perception and Entertainment-application usage negatively predicting time perception. In the Social Media condition, use of applications in the Games category negatively predicted time perception. Finally, in the Lecture condition, use of applications in the Productivity category positively predicted time perception. It is unclear why use of different categories of smartphone applications might better predict differences in perception of passing time. Future research would benefit from investigating the various ways differences in smartphone use might influence perception of passing time.

Summary

It was predicted the perception of passing time would be greater under conditions lacking stimulation or entertainment compared to conditions under which individuals are stimulated. Results from analyses not controlling for the influence of working memory and intelligence did not support this hypothesis with no significant differences between perception of passing time being seen across the three experimental conditions. However, upon controlling for the influence of both working memory and intelligence on time perception, experimental condition was shown to be significant in predicting perception of passing time with individuals in the lecture condition perception more time as passing compared to those watching the social media use video. Although it was surprising that participants did not perceive more time as passing while waiting compared to the other two settings, results from the present study do suggest that individuals do perceive more time to pass when less stimulated while attending an academic lecture, for example, than when they are engaging in social media use – a likely more stimulating and entertaining setting.

It was also predicted that participants with greater amount of smartphone use who are inactive or unstimulated would perceive that a significantly greater amount of time passed during the experiment compared to those with moderate or low smartphone use. The findings of the present study support this hypothesis somewhat. Marginally significant results suggest that individuals who use their smartphone devices more frequently perceive a greater amount of time as passing while attending academic lectures compared to when they are waiting or engaging in social media use. Although the results of this study do not meet even a liberal statistical significance level, it is possible that, under certain circumstances, amount of emerging adult smartphone use may play a part in how they perceive time to pass when stimulated or unstimulated.

Finally, it was hypothesized that boredom proneness would be positively related to both smartphone use and perception of passing time and that it would mediate the relationship between smartphone use and time perception. Surprisingly, boredom proneness was not shown to be related to frequency of emerging adult smartphone use, suggesting that boredom proneness likely does not motivate emerging adults to use their smartphone devices more often. Additionally, these findings suggest that frequency of smartphone use likely does not cause emerging adults to experience elevations in levels of boredom proneness. These findings conflict with those found by Biolcati et al. (2018) in a sample of adolescents. It is possible that motivations for smartphone use may differ depending upon stage of life.

Similarly, emerging adult boredom proneness was not shown to impact time perception for individuals while waiting or while indirectly participating in social media. Although boredom proneness was shown to influence perception of passing time for individuals in a simulated academic lecture setting, the direction of the relationship was counter to the original hypothesis with elevations in boredom proneness predicting a lower perceived duration of the video. It is possible that individuals who are more prone to boredom tend to lose track of time more easily due to resorting to day-dreaming when experiencing boredom.

Limitations

The current study is not without limitations. First, the sample was drawn from a predominantly Caucasian and female college student sample limited to one department on campus. Future research would benefit from investigating these relationships in a more diverse population. The current study also focused on university-attending emerging adults; however, future research ought to investigate these relationships across education levels as well as across the lifespan, specifically in adolescents.

Additionally, the sample size for this study is small. This was partially due to the removal of participants due to incomplete survey data, administration errors, and being invalid. However, the small sample size for this study was primarily due to collection of objective smartphone use data being limited to iPhone users resulting in the exclusion of all Android smartphone users. Future research should examine these constructs in a larger, more generalized sample. Data gathered to assess frequency of smartphone use was also limited even for participants who owned iPhone smartphone devices. Participants who owned iPhone smartphone devices who had updated their smartphone device operating systems within the previous week were unable to report smartphone usage data resulting in further limiting usable study data. Finally, participants reported the amount of time they used their smartphone devices in the prior week and this data was used to represent average weekly smartphone use. Future studies ought to use a more comprehensive and long-term approach to evaluating average weekly smartphone use.

Implications

This study's findings help to clarify relations between technology use, specifically smartphone use, in emerging adult boredom proneness and perception of passing time. Findings from the present study suggest that university-attending emerging adults perceive a greater amount of time to be passing while attending lectures compared to when they are entertained by social media. Further research should strengthen the present study's findings regarding the role of smartphone use frequency in perception of passing time in academic lecture settings, as well.

Finally, this study's findings indicate that motivations for smartphone use may differ in adolescence and emerging adulthood with boredom proneness being less of an influence on smartphone use frequency in an emerging adult population. Future research should examine relations between various facets of impulsivity – such as sensation seeking and negative urgency – and perception of passing time and possibly how impulsivity interacts with smartphone use and perception of passing time in various settings.

Table 1: Demographics of Participants Included in Study.

	n	%
Sample Size	207	
Ethnicity		
African American	11	5.3
Asian	15	7.2
Caucasian	117	56.5
Hispanic	44	21.3
Native American	1	0.5
Mixed	19	9.2

	m	*SD*
Age	19.4	2.7

Table 2: Demographics of Participants Included in Analyses.

	n	%
Sample Size	164	
Ethnicity		
African American	8	4.9
Asian	9	5.5
Caucasian	96	58.5
Hispanic	35	21.3
Native American	1	0.6
Mixed	15	9.1

	m	*SD*
Age	19.3	1.2

Table 3: Correlations between Primary Study Variables in Waiting Condition.

	1.	2.	3.	4.	5.	*m*	*SD*
1. Smartphone Use		-0.08	-0.13	-0.01	0.07	27.30	14.95
2. Boredom Proneness			-0.10	0.03	-0.18	86.74	13.00
3. Time Perception				-0.09	0.06	8.37	2.81
4. Intelligence					0.22	102.96	11.24
5. Working Memory						61.68	8.84

* $p < .05$.

** $p < .01$.

Table 4: Correlations between Primary Study Variables in Social Media Condition.

	1.	2.	3.	4.	5.	*m*	*SD*
1. Smartphone Use		0.05	0.04	-0.25	0.02	28.32	16.81
2. Boredom Proneness			-0.22	0.20	0.03	88.42	11.93
3. Time Perception				-0.19	0.08	7.86	3.27
4. Intelligence					0.34*	99.93	11.35
5. Working Memory						61.15	10.04

* p < .05.

** p < .01.

Table 5: Correlations between Primary Study Variables in Lecture Condition.

	1.	2.	3.	4.	5.	*m*	*SD*
1. Smartphone Use		-0.09	0.04	0.21	-0.00	27.79	16.22
2. Boredom Proneness			-0.31*	-0.29	0.16	89.74	9.71
3. Time Perception				0.05	-0.15	9.20	3.76
4. Intelligence					0.33*	102.93	11.06
5. Working Memory						61.16	10.27

* $p < .05$.

** $p < .01$.

Table 6: Correlations between Primary Study Variables Independent of Condition.

	1.	2.	3.	4.	*m*	*SD*
1. Smartphone Use		-0.04	-0.04	0.03	27.78	15.86
2. Boredom Proneness			0.00	-0.02	88.20	11.72
3. Intelligence				0.00**	102.00	11.23
4. Working Memory					61.35	9.63

* p < .05.

** p < .01.

Figure 1: Relationships between smartphone use, experimental condition, and perception of passing time controlling for the influence of intelligence and working memory.

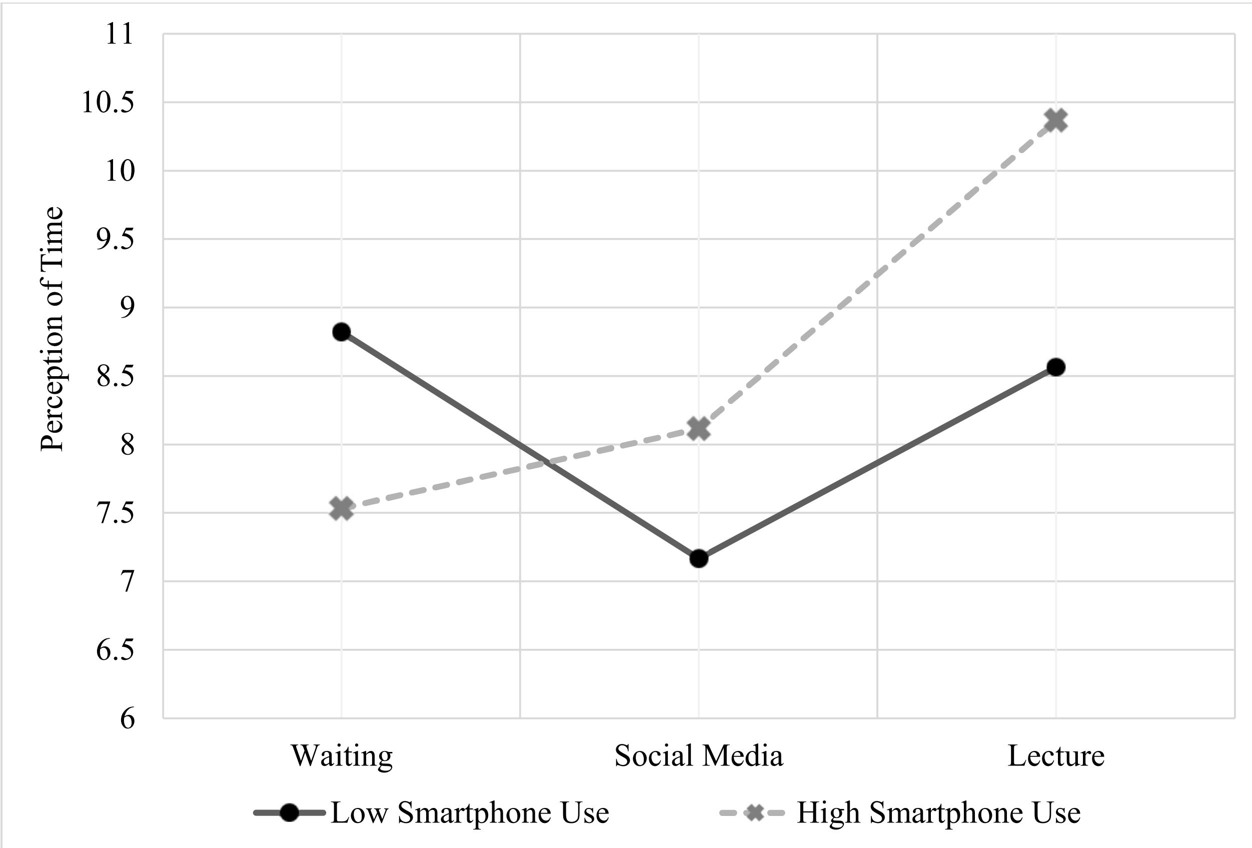


Figure 2: Relationships between boredom proneness, experimental condition, and perception of passing time controlling for the influence of intelligence and working memory.

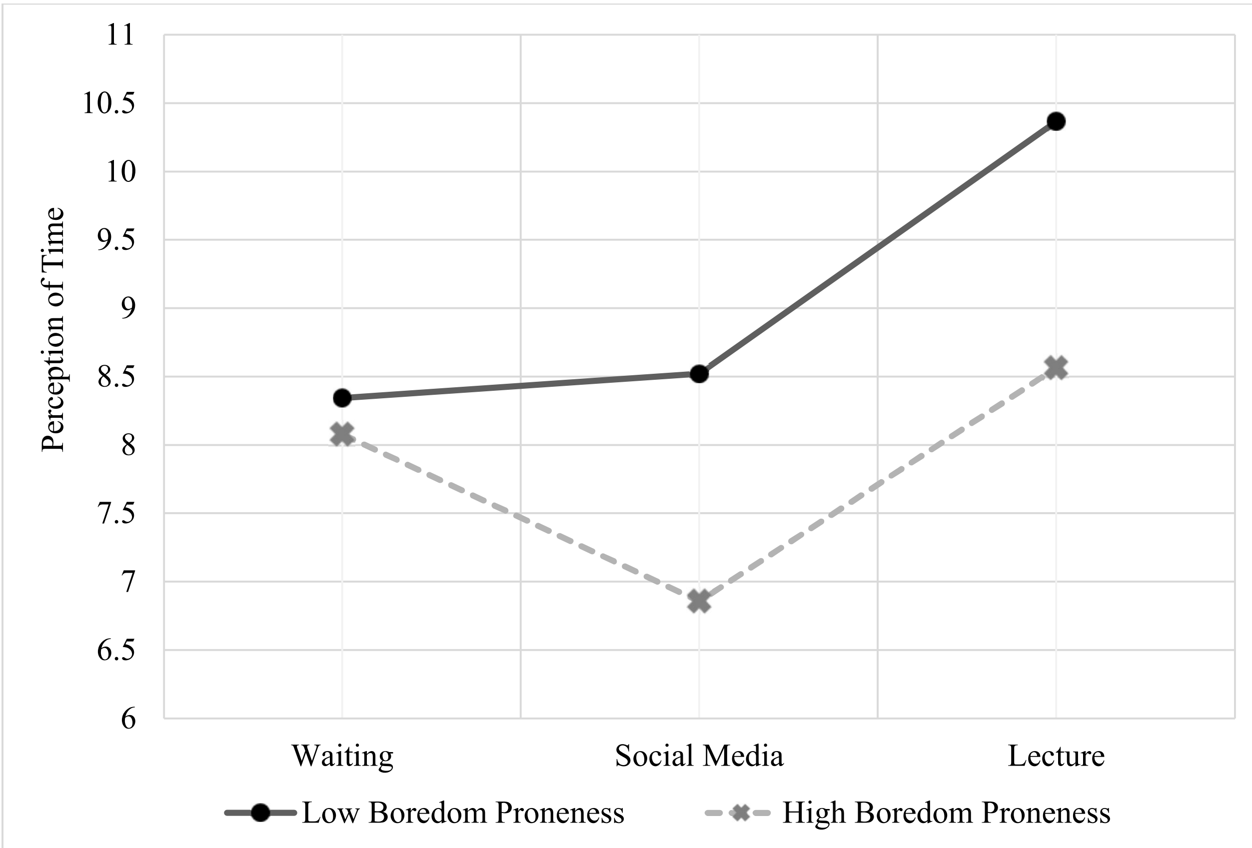
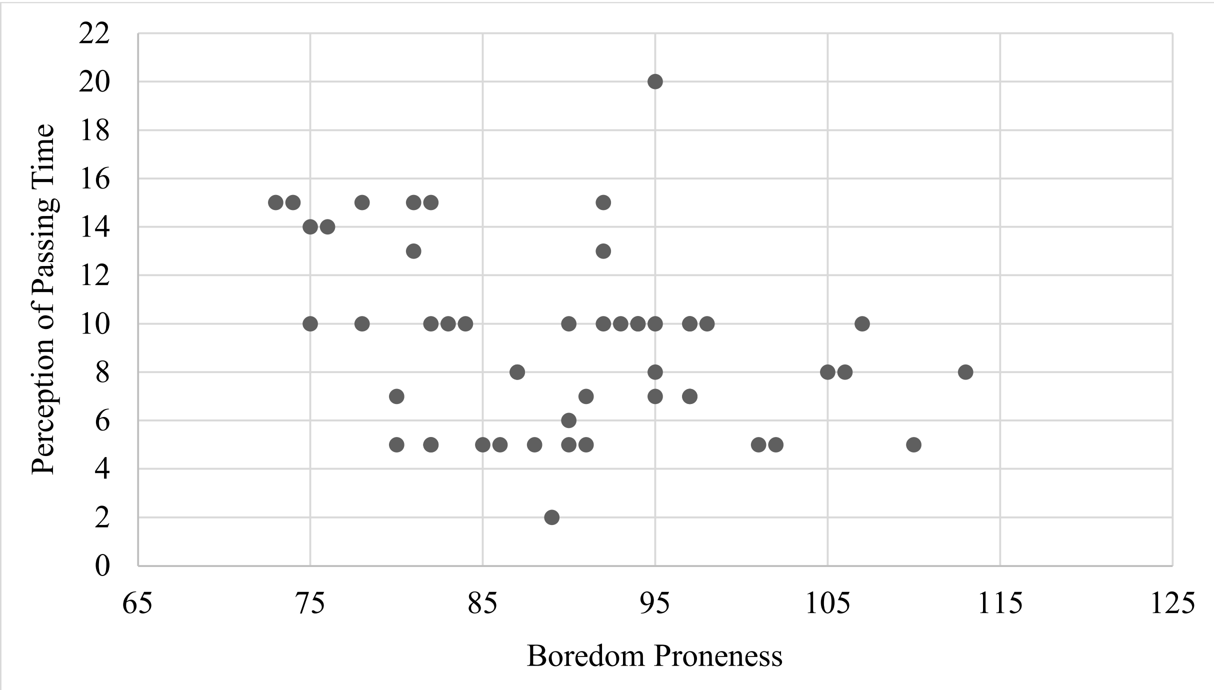


Figure 3: Relationship between boredom proneness and perception of passing time in the Lecture Condition.



REFERENCES

Andrews, S., Ellis, D. A., Shaw, H., & Piwek, L. (2015). Beyond Self-Report: Tools to Compare Estimated and Real-World Smartphone Use. *Plos One, 10*(10), e0139004. doi:10.1371/journal.pone.0139004

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist, 55*(5), 469-480. https://doi-org.srv-proxy2.library.tamu.edu/10.1037/0003-066X.55.5.469

Barratt, E. S. (1959). Anxiety and impulsiveness related to psychomotor efficiency. *Perceptual and Motor Skills, 9,* 191-198.

Bauermeister, J. J., Barkley, R. A., Martinez, J. V., Cumba, E., Ramirez, R. R., Reina, G., & ... Salas, C. C. (2005). Time estimation and performance on reproduction tasks in subtypes of children with attention deficit hyperactivity disorder. *Journal Of Clinical Child And Adolescent Psychology, 34*(1), 151-162.

Bianchi, A., & Phillips, J. G. (2005). Psychological predictors of problem mobile phone use. *Cyberpsychology & Behavior: The Impact Of The Internet, Multimedia And Virtual Reality On Behavior And Society, 8*(1), 39-51.

Billieux, J. (2012). Problematic use of the mobile phone: A literature review and a pathways model. *Current Psychiatry Reviews, 8*(4), 299-307. doi: 10.2174/157340012803520522

Billieux, J., Van der Linden, M., & Rochat, L. (2008). The role of impulsivity in actual and problematic use of the mobile phone. *Applied Cognitive Psychology, 22*(9), 1195-1210.

Billieux, J., Van Der Linden, M., D'Acremont, M., Ceschi, G., & Zermatten, A. (2007). Does impulsivity relate to perceived dependence on and actual use of the mobile phone?. *Applied Cognitive Psychology, 21*(4), 527-537. doi:10.1002/acp.1289

Biolcati, R., Mancini, G., & Trombini, E. (2018). Proneness to boredom and risk behaviors during adolescents' free time. *Psychological Reports, 121*(2), 303-323. doi:10.1177/0033294117724447

Biolcati, R., Passini, S., & Mancini, G. (2016). ''I cannot stand the boredom.'' Binge drinking expectancies in adolescence. *Addictive Behaviors Reports, 3*, 70–76.

Bjornsen, C. A., & Archer, K. J. (2015). Relations between college students' cell phone use during class and grades. *Scholarship Of Teaching And Learning in Psychology, 1*(4), 326-336. doi:10.1037/stl0000045

Burnell, K., & Kuther, T. L. (2016). Predictors of mobile phone and social networking site dependency in adulthood. *Cyberpsychology, Behavior, And Social Networking, 19*(10), 621-627. doi:10.1089/cyber.2016.0209

Carr, N. (2011). *The shallows: What the internet is doing to our brains.* New York: W. W. Norton.

Chowdhury, N. S., Livesey, E. J., Blaszczynski, A., & Harris, J. A. (2017). Pathological gambling and motor impulsivity: A systematic review with meta-analysis. *Journal Of Gambling Studies, 33*(4), 1213-1239. doi:10.1007/s10899-017-9683-5

Clayson, D. E., & Haley, D. A. (2013). An introduction to multitasking and texting: Prevalence and impact on grades and GPA in marketing classes. *Journal Of Marketing Education, 35*(1), 26-40. doi:10.1177/0273475312467339

Corvi, A. P., Juergensen, J., Weaver, J. S., & Demaree, H. A. (2012). Subjective time perception and behavioral activation system strength predict delay of gratification ability. *Motivation And Emotion*, 36(4), 483-490.

Divband, F. (2013). Relationships between sensation seeking, leisure boredom, and self-esteem, with addiction to cellphone. *Psychological Research, 15*(2), 30-47.

Farmer, R., & Sundberg, N. D. (1986). Boredom Proneness--The Development and Correlates of a New Scale. *Journal of Personality Assessment, 50*(1), 4-17. doi:10.1207/s15327752jpa5001_2

Gentile, D. (2009). Pathological video-game use among youth ages 8 to 18: A national study. *Psychological Science, 20*(5), 594-602. doi:10.1111/j.1467-9280.2009.02340.x

Gonidis, L., & Sharma, D. (2017). Internet and Facebook related images affect the perception of time. *Journal Of Applied Social Psychology, 47*(4), 224-231. doi:10.1111/jasp.12429

Greenfield, D. N. (1999). Psychological characteristics of compulsive internet use: a preliminary analysis. *Cyberpsychological Behavior*, 2, 403-412.

Grondin, S. (2010). Timing and time perception: A review of recent behavioral and neuroscience findings and theoretical directions. *Attention, Perception, & Psychophysics, 72*(3), 561-582. doi:10.3758/app.72.3.561

Ha, J., Chin, B., Park, D., Ryu, S., & Yu, J. (2008). Characteristics of excessive cellular phone use in Korean adolescents. *Cyberpsychology Behavior, 11*, 783–784. doi:10.1089/cpb.2008.0096

Harman, B. A., & Sato, T. (2011). Cell phone use and grade point average among undergraduate university students. *College Student Journal, 45*(3), 544-549.

Harris, B., Regan, T., & Fields, S. A. (2020). Boredom proneness moderates relations between smartphone use and smartphone addiction. *Unpublished manuscript.*

Hayashi, Y., Miller, K., Foreman, A. M., & Wirth, O. (2016). A behavioral economic analysis of texting while driving: Delay discounting processes. *Accident Analysis And Prevention, 97*(132-140). doi:10.1016/j.aap.2016.08.028

Ho, R. C., Zhang, M. W., Tsang, T. Y., Toh, A. H., Pan, F., Lu, Y., & ... Mak, K. (2014). The association between Internet addiction and psychiatric co-morbidity: A meta-analysis. *BMC Psychiatry, 14,* 183. https://doi.org/10.1186/1471-244X-14-183

Hunter, J. P., & Csikszentmihalyi, M. (2003). The positive psychology of interested adolescents. *Journal of Youth and Adolescence, 32*, 27–35.

Iso-Ahola, S. E., & Crowley, E. D. (1991). Adolescent substance abuse and leisure boredom. *Journal of Leisure Research, 23*, 260.

Jenaro, C., Flores, N., Gómez-Vela, M., González-Gil, F., & Caballo, C. (2007). Problematic internet and cell-phone use: Psychological, behavioral, and health correlates. *Addiction Research & Theory, 15*(3), 309-320.

Kaess, M., Durkee, T., Brunner, R., Carli, V., Parzer, P., Wasserman, C., & ... Wasserman, D. (2014). Pathological Internet use among European adolescents: Psychopathology and self-destructive behaviours. *European Child & Adolescent Psychiatry, 23*(11), 1093-1102. doi:10.1007/s00787-014-0562-7

Kaufman, A., & Kaufman, N. (2004). *Kaufman brief intelligence test: KBIT 2 ; manual* (2. ed.). Bloomington, Minn: Pearson.

Kim, J. (2018). Psychological issues and problematic use of smartphone: ADHD's moderating role in the associations among loneliness, need for social assurance, need for immediate connection, and problematic use of smartphone. *Computers In Human Behavior, 80*(390-398). doi:10.1016/j.chb.2017.11.025

Lee, H., & Yang, E. (2018). Exploring the Effects of Working Memory on Time Perception in Attention Deficit Hyperactivity Disorder. *Psychological Reports,122(1), 23-35.* doi:10.1177/0033294118755674

Leung, L. (2008). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *Journal of Children and Media, 2*(2) (2008), pp. 93-113, 10.1080/17482790802078565

Leung, L., & Liang, J. (2016). Psychological traits, addiction symptoms, and feature usage as predictors of problematic smartphone use among university students in China. International *Journal Of Cyber Behavior, Psychology And Learning, 6*(4), 57-74. doi:10.4018/IJCBPL.2016100105

Lynam, D. R., Whiteside, S. P., Smith, G. T., & Cyders, M. A. (2006). The UPPS-P: Assessing five personality pathways to impulsive behavior. West Lafayette, IN: Purdue University. Unpublished report.

Moreira, D., Pinto, M., Almeida, F., & Barbosa, F. (2016). Time perception deficits in impulsivity disorders: A systematic review. *Aggression & Violent Behavior, 27*, 87-92.

Nichols, L. A., & Nicki, R. (2004). Development of a Psychometrically Sound Internet Addiction Scale: A Preliminary Step. *Psychology Of Addictive Behaviors, 18*(4), 381-384. doi:10.1037/0893-164X.18.4.381

Panagiotidi, M. (2017). Problematic video game play and ADHD traits in an adult population. *Cyberpsychology, Behavior, And Social Networking, 20*(5), 292-295. doi:10.1089/cyber.2016.0676

Radonovich, K. J., & Mostofsky, S. H. (2004). Duration Judgments in Children With ADHD Suggest Deficient Utilization of Temporal Information Rather Than General Impairment in Timing. *Child Neuropsychology, 10*(3), 162-172.

Rainie, L., & Perrin, A. (2017). 10 facts about smartphones as the iPhone turns 10. *Pew Research Center: Internet & Technology*. Retrieved October 10, 2017, from http://www.pewresearch.org/fact-tank/2017/06/28/10-facts-about-smartphones/

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). Generation M2: Media in the lives of 8- to 18-year-olds. Menlo Park, CA: The Henry J. Kaiser Family Foundation.

Roberts, J. A., Pullig, C., & Manolis, C. (2015). I need my smartphone: A hierarchical model of personality and cell-phone addiction. *Personality And Individual Differences, 7*(913-919. doi:10.1016/j.paid.2015.01.049

Rosen, I. D., Cheever, N. A., & Carrier, I. M. (2012). iDisorder: Understanding our obsession with technology and overcoming its hold on us. New York: Palgrave Macmillan.

Rosen, L. D., Carrier, L. M., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior, 29,* 948-958.

Sayette, M. A., Loewenstein, G., Kirchner, T. R., & Travis, T. (2005). Effects of Smoking Urge on Temporal Cognition. *Psychology of Addictive Behaviors, 19*(1), 88-93. Doi:10.1037/0893-164X.19.1.88

Seo, D.G., Park, Y., Kim, M. K., & Park, J. (2016). Mobile phone dependency and its impacts on adolescents' social and academic behaviors. *Computers In Human Behavior, 63*(282-292). doi:10.1016/j.chb.2016.05.026

Sheslow, D., & Adams, W. (2003). *Wide range assessment of memory and learning (2nd ed.)*. Lutz, FL: Psychological Assessment Resources, Inc.

Shur-Fen Gau, S., & Shoou-Lian, H. (2010). Deficit in interval timing may be a candidate endophenotype for attention-deficit hyperactivity disorder. *European Child & Adolescent Psychiatry, 19*, 40.

Skues, J., Williams, B., Oldmeadow, J., & Wise, L. (2016). The effects of boredom, loneliness, and distress tolerance on problem internet use among university students. *International Journal of Mental Health And Addiction, 14*(2), 167-180. doi:10.1007/s11469-015-9568-8

Sung, M., Shin, Y., & Cho, S. (2014). Factor structure of the Internet Addiction Scale and its associations with psychiatric symptoms for Korean adolescents. *Community Mental Health Journal, 50*(5), 612-618. doi:10.1007/s10597-013-9689-0

Toda, M., Monden, K., Kubo, K., & Morimoto, K. (2004). Cellular phone dependence tendency of female university students. *Japanese Journal of Hygiene, 59*, 383-386.

Tsai, Y., & Yeh, S. (2014). Low temporal precision for high impulsive individuals. *Personality And Individual Difference, 70*(92-96). doi:10.1016/j.paid.2014.06.044

Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory of Language, 28*, 127-154.

Vodanovich, S., Kass, S. A factor analytic study of the Boredom Proneness Scale. *Journal Of Personality Assessment, 55*(1-2), 115-123. doi:10.1207/s15327752jpa5501&2_11

Walg, M., Hapfelmeier, G., El-Wahsch, D., & Prior, H. (2017). The faster internal clock in ADHD is related to lower processing speed: WISC-IV profile analyses and time estimation tasks facilitate the distinction between real ADHD and pseudo-ADHD.

European Child & Adolescent Psychiatry, 26(10), 1177-1186. doi:10.1007/s00787-017-0971-5

Whiteside, S. P., & Lynam, D. R. (2001). The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences, 30*(4), 669-689. doi:10.1016/S0191-8869(00)00064-7

Wilson, T. D., Reinhard, D. A., Westgate, E. C., Gilbert, D. T., Ellerbeck, N., Hahn, C., & … Shaked, A. (2014). Just think: The challenges of the disengaged mind. *Science, 345*(6192). 75-77. Doi:10.1126/science.1250830

Wittmann, M., & Paulus, M. P. (2008). Decision making, impulsivity and time perception. *Trends In Cognitive Sciences, 12*(1), 7-12. doi:10.1016/j.tics.2007.10.004

Wittmann, M., Leland, D. S., Churan, J., & Paulus, M. P. (2007). Impaired time perception and motor timing in stimulant-dependent subjects. *Drug And Alcohol Dependence, 90*(2-3), 183-192. doi:10.1016/j.drugalcdep.2007.03.005

Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers & Education, 58*(1), 365-374. doi:10.1016/j.compedu.2011.08.029

APPENDIX A

DEMOGRAPHICS

1. What is your sex?
    - Male
    - Female
    - Intersex
2. How old are you?
    - 18
    - 19
    - 20
    - 21
    - 22
    - 23
    - Other: ______________
3. What classification are you?
    - Freshman
    - Sophomore
    - Junior
    - Senior
    - Graduate Student
    - Non-student
4. What is your ethnicity? Select multiple if more than one apply.
    - African-American
    - Asian

- Caucasian
- Hispanic
- Native-American
- Other: _____________

5. Have you been officially diagnosed with ADD/ADHD?
   - Yes
   - No

APPENDIX B

SMARTPHONE USE DATA COLLECTION

1. Do you own a smartphone?
   - o Yes
   - o No
2. Do you own an iPhone or Android smartphone?
   - o iPhone
   - o Android

You are now going to be asked to record the amount of time you have spent on each individual smartphone application in the past week. Do not guess or estimate how much time you spent on each smartphone application. Using your smartphone device, please follow the upcoming steps to find exact records of your smartphone usage.

3. Do you understand the instructions? If you do not understand or you are unable to provide this information for whatever reason, please explain>.
   - o Yes
   - o No: ____

Step 1: Go to your “Settings” application in your smartphone

Step 2: Scroll until you see "Screen Time" and click to gain access to phone use information.

Step 3: Click on the link at the top of the screen showing your name (Example: Bethany's iPhone)

Step 4: Select "**Last 7 Days**" at the top of the screen NOT "**Today**"

4. Record your **Weekly Total** of iPhone usage during the Last 7 Days. ________________
5. Record your **Total Pickups** during the Last 7 Days. ________________

6. Record your total **Notifications** during the Last 7 Days. _______________
7. Record the amount of time spent using applications in the **Social Networking** category.

   ____
8. Record the amount of time spent using applications in the **Productivity** category.

   ____
9. Record the amount of time spent using applications in the **Reading & Reference** category. _________________
10. Record the amount of time spent using applications in the **Education** category.

    ____
11. Record the amount of time spent using applications in the **Entertainment** category.

    ____
12. Record the amount of time spent using applications in the **Games** category.

    ____

APPENDIX C

BOREDOM PRONENESS SCALE

Rate the following items on a scale of 1-6.

1 = Strongly Disagree

2 = Disagree

3 = Slightly Disagree

4 = Slightly Agree

5 = Agree

6 = Strongly Agree

1. It is easy for me to concentrate on my activities.

   1 2 3 4 5 6

2. Frequently when I am working I find myself worrying about other things.

   1 2 3 4 5 6

3. Time always seems to be passing slowly.

   1 2 3 4 5 6

4. I often find myself at "loose ends", not knowing what to do.

   1 2 3 4 5 6

5. I am often trapped in situations where I have to do meaningless things.

   1 2 3 4 5 6

6. Having to look at someone's home movies or travel slides bores me tremendously.

   1 2 3 4 5 6

7. I have projects in mind all the time, things to do.

   1 2 3 4 5 6

8. I find it easy to entertain myself.

1 2 3 4 5 6

9. Many things I have to do are repetitive and monotonous.

1 2 3 4 5 6

10. It takes more stimulation to get me going than most people.

1 2 3 4 5 6

11. I get a kick out of most things I do.

1 2 3 4 5 6

12. I am seldom excited about my work.

1 2 3 4 5 6

13. In any situation I can usually find something to do or see to keep me interested.

1 2 3 4 5 6

14. Much of the time I just sit around doing nothing.

1 2 3 4 5 6

15. I am good at waiting patiently.

1 2 3 4 5 6

16. I often find myself with nothing to do, time on my hands.

1 2 3 4 5 6

17. In situations where I have to wait, such as a line, I get very restless.

1 2 3 4 5 6

18. I often wake up with a new idea.

1 2 3 4 5 6

19. It would be very hard for me to find a job that is exciting enough.

1 2 3 4 5 6

20. I would like more challenging things to do in life.

1 2 3 4 5 6

21. I feel that I am working below my abilities most of the time.

1 2 3 4 5 6

22. Many people would say that I am a creative or imaginative person.

1 2 3 4 5 6

23. I have so many interests, I don't have time to do everything.

1 2 3 4 5 6

24. Among my friends, I am the one who keeps doing something the longest.

1 2 3 4 5 6

25. Unless I am doing something exciting, even dangerous, I feel half-dead and dull.

1 2 3 4 5 6

26. It takes a lot of change and variety to keep me really happy.

1 2 3 4 5 6

27. It seems that the same things are on television or the movies all the time; it's getting old.

1 2 3 4 5 6

28. When I was young, I was often in monotonous and tiresome situations.

1 2 3 4 5 6